**Olfactory System and Olfaction (Molitor): Worksheet**

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1. **Identify structural features and properties of the olfactory epithelium**

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| ***Olfactory Epithelium*** |
| 1. Olfactory receptor neurons (ORNs) and associated tissues    1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_ with mucus and cell layer    2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_ with blood vessels and ORN axons 2. Inside nose along ethmoid bone of skull    1. Forms porous region of ethmoid bone: \_\_\_\_\_\_\_\_\_\_\_\_\_\_ 3. Odorant transduction occurs within ORN cilia that extend into \_\_\_\_\_\_\_\_\_ layer 4. ORN axons project to \_\_\_\_\_\_\_\_\_\_ olfactory bulb via nerve bundles through \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

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| ***Regeneration of Olfactory Neurons*** |
| 1. ORNs are unique among CNS neurons in their ability to \_\_\_\_\_\_\_\_\_\_\_\_\_\_    1. Hippocampal dentate gyrus – only other known CNS location 2. Regularly damaged by exposure to airborne pathogens and toxins 3. \_\_\_\_\_\_\_\_\_\_\_\_ cells and \_\_\_\_\_\_\_\_\_ provide protection 4. Olfactory stem cells reside near laminar surface of epithelium and serve as ORN \_\_\_\_\_\_\_\_\_\_\_\_\_\_ 5. Other olfactory neurons within CNS also regenerate 6. Olfactory stem cells – replacement for damaged neurons? |

1. **Describe how odorants are converted into olfactory nerve action potentials**

***Olfactory receptor selectivity***

1. ORNs typically exhibit single type of odorant \_\_\_\_\_\_
2. Odorant \_\_\_\_\_\_s can respond to single or multiple odorants
3. Therefore, some ORNs respond to single or multiple odorants
4. Depends on molecular structure of odorant and region of odorant binding to GPCR
5. Different GPCRs have different *\_\_\_\_\_\_\_\_\_\_\_\_* for the same odorant molecule
6. Explains how *\_\_\_\_\_\_\_\_\_\_* of odorant can change with odorant *\_\_\_\_\_\_\_\_\_\_\_*

E.g. odorant indole smells floral at low concentration, but putrid at high

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| ***Olfactory Transduction*** |
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| 1. Odorant binds to GPCR in membrane of ORN cilia (OR\*) 2. GPCR activates odorant-specific Golf 3. Activated Golf α subunit\* activates adenylyl cyclase III 4. Adenylyl cyclase III (AC III\*) converts ATP 🡪 cAMP 5. cAMP activates cyclic nucleotide-gated cation channel (CNGC) 6. Gating of CNG Channel produces influx of Na+ and Ca2+ ions; depolarization 7. Additional depolarization from Cl- efflux through Ca2+-gated Cl- channels (CaCC) 8. Depolarizing Na+ and Ca2+ influx produces APs in ORN axons that are transmitted to olfactory bulb |

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| ***Adaptation to Odorants*** |
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| ***Adaptation to Odorants*** | | |
| **1. Odorant concentration in air declines slowly** | | |
| **2. Receptor response declines with sustained odorant exposure** | | |
| **3. Ca2+ influx through CNGC channel activates intracellular CaM** | a. \_\_\_\_\_ – \_\_\_\_\_ binding closes \_\_\_\_\_\_\_ channel |  |
| b. Activates \_\_\_\_\_\_\_\_, which \_\_\_\_\_\_\_\_\_\_\_\_ and turns off \_\_\_\_\_\_\_ |
| c. Activates \_\_\_\_\_\_\_\_,which converts \_\_\_\_\_\_ 🡪 \_\_\_\_\_\_ |
| **4. –P inactivates odorant GPCR** | a. \_\_\_\_\_\_ activates \_\_\_\_\_, which –P \_\_\_\_\_\_ |  |
| b. Golf α\* activates \_\_\_\_\_\_\_\_\_\_, which –P OR |
| **5. Na+—Ca2+ and Na+—Ca2+—K+ exchangers extrude Ca2+ and restore ionic equilibrium** | | |

1. **Identify structural features and properties of the olfactory bulb**

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| ***Structure of Olfactory Bulb*** | |
|  | 1. Obligatory synapse for ascending ORN axons 2. Laminar structure located on ventral surface of forebrain 3. Mitral cell dendrites receive synaptic input from ORNs in structures known as \_\_\_\_\_\_\_\_\_\_\_\_    1. Cell axons project to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 4. \_\_\_\_\_\_\_\_\_ cells are projection neurons similar to mitral    1. Layer between mitral cells and glomeruli 5. Periglomerular cells receive synaptic input in glomeruli and project to \_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_ cell dendrites 6. \_\_\_\_\_\_\_\_\_\_ cells receive synaptic input from projection cell axons and feedback to projection cell dendrites |
| **Olfactory bulb glomeruli** |
| 1. Specialized synaptic structure in olfactory bulb 2. Each glomerulus consists of \_\_\_\_\_\_\_\_\_\_\_ from 10s of M, T, and PG cells 3. Receives synaptic input from 1000s of ORNs expressing some odorant rec. 4. Provides *\_\_\_\_\_\_\_\_\_\_\_\_\_\_* representation of odorant classes 5. Segregated by molecular structure of odorants 6. May provide *\_\_\_\_\_\_\_\_\_\_\_\_\_\_* of odorant based on related odorant structs |

1. **Describe central olfactory projections and their role in affective responses**

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| ***Central Olfactory Pathways*** |
| 1. Sensory cortical target is in \_\_\_\_\_\_\_\_ on ventral forebrain 2. Part of specialized cortex – \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 3. Output projects to multiple portions of \_\_\_\_\_\_\_\_\_\_\_ system; List e.g.’s |
| ***Olfaction, Memory, Emotion*** |
| 1. Pathways initiate responses from memory and emotion centers 2. Provide powerful territorial, reproductive cues in mammals 3. Can trigger memory associated with an odor 4. Volatile substances in food activate olfactory receptors |

1. **Understand the etiology of olfactory disorders**